AIR WEAPONS CONTROL SYSTEM 412L

QUARTERLY RELIABILITY PROGRAM

REPORT NO. 9

(AWCS-SQR-9)

31 March 1963

Prepared for

Electronics Systems Center
412L Systems Project Office
L. G. Hanscom Air Force Base, Massachusetts

By

Military Communications Department
General Electric Company
Syracuse, New York

Contract No. AF 19(628)-513

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INTRODUCTION

This report, AWCS-SQR-9, is written under Contract No. AF 19(628)-513 and prepared at the request of the 412L SPO. It covers the progress of the AWCS 412L reliability effort during the first quarter of 1963. The report is divided into two sections; Part I which covers the system reliability effort, and Part II which covers the equipment reliability effort.

PART I

SYSTEM RELIABILITY

A. SYSTEM RELIABILITY ANALYSIS (See Figure 1)

1. USAFE Simulation Program Model (SE-DOES)

The final report was distributed this past quarter. No further work, or reporting on this subject is expected in the future.

2. AWCS - 412L Operational Support Study (TEMPO)

No further work is contemplated based on the work TEMPO completed during 1962. This item will be discontinued from the report in the future.

3. Reliability Demonstration Testing

The General Electric Company is progressing rapidly in the preparation of Reliability Demonstration Tests for the nine groups of equipment in AN/GPA-73. Drafts of the demonstration test plans have been submitted to the Air Force for their review and comment. The General Electric Company has received comments and/or verbal approval on all drafts except the OA-1718 and FSA-12 groups. Comments and/or verbal approval for these drafts are expected by mid April 1963.

The comments received from the Air Force are being incorporated in the test plans at the present time. The revised test plans will be supplied to the Air Force for approval during the second quarter of 1963.

The Reliability Demonstration Tests are specifically designed to demonstrate the reliability requirements specified in AWCS-ER-1R1. They follow the basic format and content requirements required by MIL-R-26474. The basic outline of each test is as follows:

Section I	Purpose
Section II	Equipment Requirements
Section III	Reliability Requirements and Failure Definition
Section IV	Test Procedures
Section V	Report Requirements

The Reliability Demonstration Tests will be performed during a three-week period, specified by the Joint Test Force, of the Category II test environment.

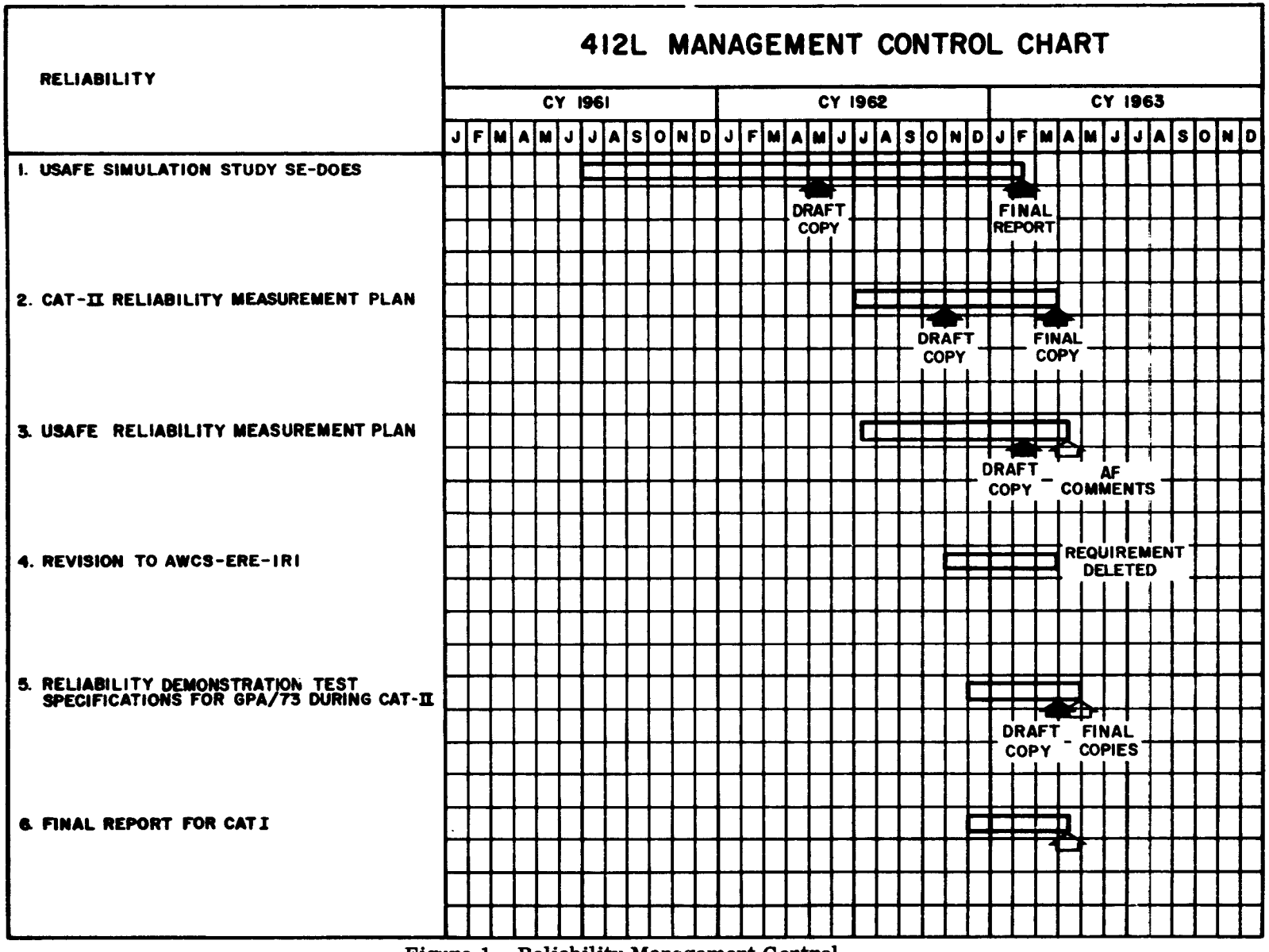

Figure 1. Reliability Management Control

During this period, the following equipment groups are to be tested to reliability goals of:

1)	Performance Monitor Group	56.24 hours
2)	Status Display Group	115.00 hours
3)	Situation Projection Group	40.06 hours

The Situation Projection Group tests are not completely firm at this time since the light valve may not be available at CAT-II environment. These details will be worked out later.

The required Mean-Time-Between-Failures (MTBF) by equipment groups are:

1)	FSA-12	7.87 hours
2)	FSA-21	3.70 hours
3)	FSA-23	14.59 hours
4)	OA-1718	30.72 hours
5)	OA-1723	7.66 hours
6)	OA-1724	8.22 hours

B. MAINTAINABILITY

The maintainability committee formed to survey the maintenance aspects of the AN/GPA-73/412L has developed a program plan to evaluate and coordinate the implementation of maintenance actions on the AN/GPA-73. This program which has been submitted to the 412L SPO for their consideration and approval includes the basic items of defining and documenting the three levels of maintenance below:

1) Level I - Periodic System Performance Checks: Determine and define the performance monitoring procedures to be employed to gain a high probability that the mission function will be successful.
2) Level II - Periodic Equipment Maintenance Procedures: Determine and define the preventive maintenance procedures to be followed in removing potentially defective parts, or performing alignment. The procedure and period of application is to be delineated.
3) Level III - Troubleshooting: Interruptive maintenance procedures and routines are to be defined and checked out.

In the foregoing program is an inclusion to overcome the difficulties encountered in obtaining meaningful maintainability data from CAT-I test environment. The deficiencies noted in CAT-I are now in the process of correction, and will be implemented during the coming quarter.

Further and greater emphasis is being placed on the evaluation of maintainability in the CAT-II and USAFE environments. The status of the software is being reviewed and checked in preparation for implementing its use at the various sites. Guidebooks for all cabinets have been prepared. Operators and maintenance personnel are being assigned to the performance monitoring group. These actions will help to better evaluate the maintainability of the system.

C. SUBCONTRACTORS

1. Radio Corporation of America

a. Converter Groups, AN/GKA-10 and AN/GKA-11

The reliability demonstration test report has been supplied to the Air Force for approval. The environmental test results have been studied, and RCA has been directed to correct certain deficiencies in the test report. These deficiencies were primarily hardware failures which were incurred during vibration and shock testing. Modifications have been made to the equipment design, and mod kits are being implemented in the field, as covered by ECR-826.

b. Monitor Transmitter Group, AN/GKA-13

The formal test report on the reliability demonstration test conducted at Camden, New Jersey on the GKA-13 has been returned to RCA for minor modifications. These are due on April 1, and will be forwarded to the Air Force for approval after review by General Electric.

2. North Electric Company

The Electronic Switching Center reliability demonstration report was submitted to the Air Force for approval this past quarter. The demonstration tests for the console subscriber sets, field subscriber sets and desk subscriber sets have also been completed and a report of the tests has been submitted to the Air Force for approval. A test program for demonstration of the machine subscriber sets, and radio channeling sets is in the process of preparation. It is proposed that the test program be conducted in conjunction with the CAT-II tests.

The switching centers have been installed at CAT-II test sites in a short time and have become operational. There have been very few failures during the period. Units in USAFE are working well. Site cooling problems in several USAFE sites may jeopardize reliability of the Electronic Switching Center if not corrected.

3. American Astro Systems, Inc.

No reliability problems have been reported on the mobile refrigeration system. The chiller bases continue to operate with no trouble.

4. Sprague Corporation (formerly Leach Corporation)

There are no items to report this quarter.

5. TEMPCO (formerly Fenske, Fedrick, and Miller, Inc.)

There is no change in the status of the Geographic Data Projection equipment during this past quarter.

6. Cook Electric Co. (Data Storage Division)

Work in the non-standard parts area was completed this past quarter. There will be no further reporting unless a problem develops.

The tape transports received in Europe were, in varying degrees, in a damaged condition due to shipping. These units have been or are being repaired locally and appear to be satisfactory. A trip was made to assess the effect the damage had on operation, and after a detail analysis of the operation of the tape transports, it was determined that the tape transport was functioning properly. Residual damage from the reliability view point has not been assessed. Close watch will be maintained in this area.

7. General Electric Company - Distribution Assemblies Department

There is no change in status of the reliability aspects of this subcontract during this quarter.

8. General Electric Company - Specialty Control Department

During this past quarter the qualification testing was continued. Completion of testing is expected during the second quarter of 1963, at which time a final report will be prepared.

9. General Electric Company (TPO)

The light valve was modified this past quarter, and an engineering evaluation test was run in Building 15, Electronics Park, Syracuse, New York. During the two-week period, data was developed in the area of reliability and maintainability. The data developed is summarized below:

1) MTBF	11.6 hours
2) MTTR	26.3 minutes
3) Intrinsic Availability	96.4 percent
4) Mean-Time-to-Adjust	3.23 minutes
5) Switchover Time	6.4 minutes

One problem developed during this period in the high-voltage divider modification. The circuit was changed in the middle of the test, and the problem now appears to be corrected. Data will be continued during normal operation of Building 15 to verify that the fix is adequate.

The light valves in European Sites F and H were also evaluated. This data indicates that the over-all usefulness of the large Situation Display Group is adequate for the intended mission function.

10. General Electric Company - Military Communications Department

There have been no further developments in the reliability area of the Receiver Group AN/GKA-12.

11. Summary of Subcontractors

Table 1 summarizes the Subcontractor Reliability Program to date.

D. MTBF, MTTR, AND AVAILABILITY FIGURES

The following tables are prepared to show the expected MTBF, MTTR, and Availability Predictions for the 412L System and subsystems:

1) Table 2 lists the data of the various subsystems and systems of 412L. This data is computed, assuming redundancy of the various subsystems in a netted configuration, as indicated on the table.

2) Table 3 is data obtained from the Air Force. A typical site of radar equipment is configured to determine the data for a typical CRC site.

3) Table 4 is data for the AN/GPA-73, listed by groups. Since the equipment can be configured in a large variety of ways, a typical CRC configuration is given.

4) Table 5 lists the data for the communication subsystem. Again, because of the many sets available for configuration, a typical CRC site was used in predicting the subsystem reliability.

5) Table 6 lists the data for the ancillary subsystem groups.

Table 1. Summary of Subcontractor Reliability

Subcontractor	Equipment Name	MTBF Reliability Goal	MTBF Reliability Prediction	Status of Reliability Measured or Demonstrated
RCA	Converter Group	350 hours MTBF	350 hours MTBF	Report submitted to the Air Force
RCA	Monitor Transmitter	1210	1210	MTBF verified by test
American Astro, Inc.	Cooling Equipment	15,000 hours MTBF on major components	Lowest MTBF per component 76,000 hours	Several design problems being fixed ECR No. 862
Sprague Corp.	Motor Generator	5,000 hours MTBF	6,850	Not available
TEMPCO	Iconorama Projector	S.G. 610 hours MTBF	S.G. 610 hours MTBF	755 hours MTBF
	P.S. and Symbol Generator	P.S. 910 hours MTBF	P.S. 910 hours MTBF	1,211 hours MTBF
Cook Electric	Tape Transport	4,000 hours MTBF	2,500 hours MTBF	Not available
G.E. DAD	Power Dist. Panels	838 hours MTBF	16,000 hours MTBF	Not available
G.E. SCD	15-kw Static Freq. Converter	10,000 hours MTBF	8,200 hours MTBF	Not available
G.E. TPO	Light Valve	50 hours MTBF	50.34 hours MTBF	Not available
G.E. DSD	Receiver Group	833 hours MTBF	1,430 hours MTBF	500-hour test completed without failure
North Electric	Electronic Switching Center	800 hours MTBF	806 hours MTBF	MTBF verified by test

Table 2. AWCS 412L Reliability Predictions for Netted System
(31 March 1963)

Subsystem	MTBF (hours)	MTTR (minutes)	Availability (%)
Data Acquisition	7,000*	42	99.99
Data Processing and Display	13.59*	8.28	98.98
Communications	5,000*	54	99.98
Ancillary	3,300	23	99.99
Overall System	13.47	8.52	98.97

* Predictions based on redundancy

Table 3. Data Acquisition Subsystem Reliability Predictions
(31 March 1963)

Equipment**	MTBF (hours)	MTTR (minutes)	Availability (%)
AN/FPS-7C	167	36	99.64
AN/FPS-20	184	84	99.25
AN/GPS-4	92.5	54	99.03
AN/FPS-6	143	36	99.58
AN/MPS-14	143	36	99.58
AN/UPX-6	603	54	99.85
Radar Signal Processor	184	12	99.89
Typical Subsystem*	91.66	44.5	99.66

* Single site reliability prediction - every component failure assumed a subsystem failure.

** Based on data furnished by the Air Force.

Table 4. Data Processing and Display Subsystem Reliability Predictions
(31 March 1963)

Equipment	MTBF (hours)	MTTR (minutes)	Availability (%)
AN/FSA-12	17.90	6	99.44
OA-1723	8.96	12	97.82
OA-1724	16.68	6	99.40
OA-1718	60.50	6	99.83
AN/FSA-21	4.50	6	97.83
AN/FSA-23	24.87	12	99.20
Status Display	42.07	12	99.53
Situation Projection	34.78	12	99.43
Performance Monitor	61.27	12	99.67
Typical Subsystem*	1.74	8.28	92.55
*Single site reliability prediction - every component failure assumed a subsystem failure.			

Table 5. Communication Subsystem Reliability Predictions
(31 March 1963)

Equipment	MTBF (hours)	MTTR (minutes)	Availability (%)
Electronic Switching Center	800	6	99.99
Flight Control Package	189	10	99.92
Subscriber Sets	9090	10	99.99
AN/TRC-24	258	56	99.68
R-278	2000	66	99.95
R-361	2100	78	99.94
T-217	700	114	99.73
BC-639	2680	60	99.97
AN/FGC-25	1000	132	99.78
AN/FGC-20	1000	57	99.91
Typical Subsystem*	1931	59	99.95
*A single-site link reliability prediction			

Table 6. Ancillary Subsystem Reliability Predictions
(31 March 1963)

Equipment	MTBF (hours)	MTTR (minutes)	Availability (%)
Temperature Control Group	5000	30	99.99
Prime Power Group	8950	10	99.99

E. RELIABILITY MEASUREMENTS

1. Systems Reliability Measurements

The final report for the Reliability Program for Category I Field Test was prepared in draft form, prior to its reproduction as AWCS-SR-5. The draft was presented to SPO at the monthly reliability co-ordination meeting. The report contains all measured figures for reliability and maintainability, together with part failure rates as calculated from Category I data. Portions of the data have been extracted from the report and included in Part II of this report in tables 12 through 31.

The "Proposed AWCS 412L Systems Test Procedure for Reliability Measurements and Failure Reporting During Category II Field Tests" was discussed with the Joint Test Force representatives at a meeting in the Category II environment. Changes were agreed on and approval was received from the SPO, dependent upon incorporation of the changes in the final procedures. The changes were included in the plan, and the revised plan was issued under SK69083-706-50. The plan will be implemented with the start of Category II testing. Failure reporting during the installation and checkout period is continuing, as mentioned in the report for the previous quarter.

2. Equipment Reliability Measurements

Equipment reliability and failure investigation information is contained in Part II of this report.

The In-Factory Unit Test Reliability Report was completed and distribution is being made within the company. Because of the decreased production, data collected during December,

January, and February was combined and analyzed. Summary information from this report is contained in Part II, paragraph C.1 of this report.

F. TRAINING AND EDUCATION

The following Product Service Engineering Memos were initiated or processed by Reliability Engineering during the first quarter of 1963:

Geographical Data Console	-	CWD Projection Lamp Life
PWB Tape Marking	-	Test Point Markings
PWB Contact Fingers	-	Contact Cleaning Instructions
PWB Transistors	-	Solder-tin transistors with gold plated leads
OPA-3, VSM-1, VSM-2 and DYC-1 PWB's	-	Logistics problem due to high reject rate
RLB PWB's	-	Preventive maintenance
3300 uufd Capacitors	-	Excessive failure rate
2N634A and 2N635A Transistors	-	Non-interchangeability with 2N634 and 2N635 types

Engineering Memos are used by field personnel to discuss problem areas, and as information reference sources in the maintenance and operations functions.

The "Reliability by Design" course was continued this quarter. The course, which was presented to 15 design engineering and other professional personnel, consists of the following subject matter:

1) Probability and Statistics
2) Distribution Functions
3) Reliability Prediction
4) Reliability Testing
5) Reliability Measurements
6) Chemical Reaction and Reliability
7) Heat Transfer and Reliability
8) Mechanical Design and Reliability

9) Radiation Effects and Reliability

10) Component Mechanisms of Failure

11) Circuit Design Analysis

12) Case History

This course is conducted for 16 weeks at two hours per week, and its purpose is to develop the criteria for making decisions during the design period.

Examples of component failure mechanisms and failure investigations encountered as a part of reliability measurements of the AWCS 412L were discussed with the class during this quarter.

G. MEETINGS

The following meetings were held this quarter:

1) 9 January 1963 with 412L SPO and AFPR at Syracuse, N.Y.

2) 11 January 1963 with RADC at Syracuse, N.Y.

3) 23 January 1963 with 412L SPO, ESD, and RADC at Waltham, Mass.

4) 14 February 1963 with 412L SPO, RADC, AFPR and ESD at Syracuse, N.Y.

5) 27 February 1963 with 412L SPO, JTF, RADC, 727th Maintenance from TAC, and MITRE Corp. at Myrtle Beach, S.C.

6) 14 March 1963 with 412L SPO, ESD, and RADC at Waltham, Mass.

7) 20, 21 March 1963 Phasing Group meeting at Waltham, Mass.

8) 22 March 1963 with RADC at Syracuse, N.Y.

PART II

EQUIPMENT

A. STANDARDS

Reporting continuity is maintained with previous program reports. Items requiring further activity based on previous reports, and not discussed in this report, indicate no action on the project during the current reporting period.

1. Specification Activity

Action directed toward establishment of a detailed specification in MIL format on diode type 1N2032-2 has been held in abeyance. Information has been received that activity is underway to develop a MIL specification on another type (1N3826A), which could be used as a direct replacement for the 1N2032-2 in 412L applications.

B. COMPONENTS

1. Failure Investigation

a. Tube Type 6021

Investigation of the high failure rate of OPA-1 and OPA-3 circuit boards indicated the primary cause of failure to be grid leakage current which increased with operating life in type 6021 tubes until the current exceeded circuit tolerance limits. The cause was found to be due to sublimation of cathode material which tended to condense on the tube base, creating leakage paths between tube elements. The tube supplier advised General Electric that this condition did not become evident in qualifying these tubes to MIL specifications because of requirements that qualification tests be run at elevated bulb temperatures. Consequently, this did not establish a condition where vapors would condense so as to result in excessive leakage.

The increased grid leakage developed by the 6021 in OPA boards could not be tolerated by ZA-1 and ZA-2 boards used in conjunction with the OPA boards. To combat this failure problem, a modification program has been instituted to change the value of four composition resistors on ZA-1 and ZA-2 boards to allow stabilization of respective OPA boards, even if 6021 grid leakage current is many times greater than tube specification limits. This should result in a great improvement in failure rate of OPA-1 and OPA-3 boards.

b. High Voltage Power Supplies (7744490 & 7744492)

An investigation is being conducted to determine the cause of rejecting several of these units. These were rejected, during preventive maintenance, as having changed value. It is suspected that the units are still functioning properly, and that it is only the test point voltage that varies. This could be caused by a change in value of the high-value resistors in the voltage divider network which establishes this test voltage.

2. Data Reduction and Dissemination

There has been no activity to report during this work period.

The previous quarterly report, AWCS-SQR-8, contains a tabulation of transistor and semiconductor diode operating life test data. This data was generated by several vendors in compliance with General Electric Transistor Reliability Specification 7070979, and General Electric Semiconductor Diode Reliability Specification 7087404. The tabulation of data includes electrical characteristics of each reading point in time, number of failures, and failure rates.

At the request of SPO and RADC, this tabulation of data was reduced to a five-page summary in AWCS-SQR-8 from forty-seven pages in AWCS-SQR-6.

3. Test Program (Reliability Engineering Laboratory)

a. Lamps (327)

The life test for these lamps has reached 15,440 hours with results as follows:

1)	35 units at 28v.	-	32 failures	=	.169% per 1000 hrs.
2)	35 units at 23v.	-	17 failures	=	.09 % per 1000 hrs.
3)	35 units at 21v.	-	8 failures	=	.042% per 1000 hrs.

This test is cycled fifteen minutes off and fifteen minutes on, to simulate actual expected operating conditions. Since the lamp is used at 21 volts in 412L equipment, the measured failure rate of .042 percent per thousand hours is indicative of the failure rate to be expected in 412L service.

b. Relay Life Test (7747350)

Five relays have been on life test for 8544 hours. The relays are cycled, making and breaking three times per minute. Each relay has completed 1,537,920 cycles with no failure.

c. High Voltage Power Supply (774449L)

The power supply on test has accumulated 14,616 operating hours without significant change in operation. This is approximately 50% greater than the minimum design life specified by purchase part specifications.

d. Zeroing Amplifier Board (ZA-1)

The ZA-1 board test has reached 10,208 hours of testing. Three boards are on test. Each board contains two independent circuits which work with associated OPA-1 boards to maintain signal voltage levels at zero volts ±10 millivolts. This test covers six functioning circuits. One tube failure in an OPA board occurred thus far which caused that circuit to drift 48 millivolts. Therefore, circuit failure rate measured at this point is .016 failures per 1000 hours. This greatly exceeds the performance of the electro-mechanical sampling switch this circuitry replaced, which exhibited less than 500 hours life until failure occurred.

e. Cathode Ray Tube 16AMP7 (G.E. Co. No. 7207962)

This is a 16-inch CRT used for display purposes in the AN/GPA-73 equipment. The life test on these tubes was terminated at 5086 hours. The test data has been reviewed, and a technical memorandum has been issued describing the results. The cathode current, as well as other parameters of the tubes, remained within the specification defined in 7070890. This indicates that these tubes are superior to tubes previously tested. The manufacturers of tubes on this test will be the major suppliers for future procurements.

f. Transistors

The results accumulated to date for all transistors on life test in the Reliability Engineering laboratory are summarized in Table 7.

Table 7. GECS Reliability Engineering Transistor Test Data

Transistor Type	Manufacturer	No. Hrs.	Qty.	Total Device Hours	Power Dissipation	Degradation Failures		Catastrophic Failures		Total Maj. & Cat. Failures	Expected Failure Rate %/1000 Hours
						I_{CBO} Major/ Minor	H_{FE} Major/ Minor	Short	Open		
USN2N388	General Instrument		110	640000	150					0	0
USN2N388	Sylvania		90	1260000	150	8		1		9	.715
USN2N396A	General Electric		60	960000	150					0	0
2N396A	Toshiba		40	320000	150	1				1	.003
2N599	Philco		60	900000	250	4				4	.004
2N604	General Instrument		60	840000	120	6	1		1	8	.0095
2N697	Rheem		50	450000	600	1 / 1				1	.002
2N699	Rheem		43	540000	600	2				2	.0037
2N699	Fairchild		60	840000	600		1			1	.001
2N1403	Texas Instrument		60	960000	250	4 / 2	6	1		11	.014
2N1450	General Instrument		60	900000	120	5 / 2	1			6	.0067
2N1450	R.C.A.		59	944000	120	1	3			4	.004
2N1450	Sylvania		48	768000	120			1	2	3	.004
2N1646	Sylvania		60	840000	150	1				0	0
2N1646	General Electric		60	480000	150	1				1	.002

C. RELIABILITY MEASUREMENTS

1. In-Factory AN/GPA-73 Reliability Reporting Data From Unit Test

The significant data from the in-factory reporting for December 1962 through February 1963 is contained in the following tables:

1) Table 8 is a summary of the electrical-type defects reported for semiconductors used on printed-wire boards. Table 8 lists the total quantities, by type, of semiconductors used on the boards checked on the Circuitron*, and the percentage of these semiconductors reported as electrically defective. In summary, the percentage of electrically-defective transistors reported at the Circuitron* was 1.15. The percentage was 0.21 for diodes.

* The Circuitron machine is a programmed type of tester capable of measuring point-to-point resistance.

2) Table 9 is a summary of the electrical-type defects reported for semiconductors used on units which were dynamically tested during the reporting period with simulated inputs. Table 10 is a summary of the defects reported from Circuitron and dynamic unit test.

3) Table 11 is a summary of the reported component-electrical defects grouped by diodes, transistors, tubes, and all other components used on units tested during December 1962, January and February 1963, and also, for comparison, the period of October - November 1962. The data originates from dynamic unit test stations.

4) Figure 2 is a graphic representation of semiconductor electrical defects reported from the Circuitron and unit test levels.

Table 8. Semiconductor Electrical Defects on Boards At Circuitron
December 1962 - February 1963

Semiconductor Type	Number Used on Boards Tested on Circuitron	Number of Electrical Defects Reported	Percentage %
1N93	70	1	1.42
1N198B	174,235	312	0.18
1N277	43,268	72	0.17
1N429	14	0	0.00
1N457	1,543	3	0.19
1N538	606	0	0.00
1N645	2,587	7	0.27
1N691	1,592	2	0.13
1N746A	901	3	0.33
1N749A	634	4	0.63
1N751A	2,379	24	1.01
1N752A	64	0	0.00
1N754A	117	0	0.00
1N756A	1,418	2	0.14
1N1521A	178	4	2.25
1N1522A	50	0	0.00
1N1806RA	58	0	0.00
1N2032-2	2,491	52	2.09
2N335	688	7	1.02
2N338	222	1	0.45
2N388	2,049	38	1.85
2N396A	1,904	19	0.47
2N492	28	0	0.00
2N525	692	0	0.00
2N553	175	0	0.00
2N595	851	9	1.06
2N599	1,238	8	0.65
2N604	4,329	74	1.71
2N697	884	9	1.02
2N699	1,029	4	0.39
2N1026A	454	5	1.10
2N1039	274	1	0.36
2N1123	142	1	0.70
2N1253	142	5	3.52
2N1403	794	13	1.64
2N1436	*	1	
2N1450	24,647	441	1.79
2N1646	27,167	132	0.49
2N2004	812	17	2.09

* The total quantity used during this period is not available. EN-47 specified usage of the 2N1436 transistor.

Table 9. Semiconductor Electrical Defects Reported At Unit Test

Semiconductor Type	Number Used on Assemblies Tested At Unit Test	Number of Electrical Defects Reported	Percentage %
1N93	1,935	0	0.00
1N198B	163,750	69	0.04
1N231	8	0	0.00
1N250B	207	4	1.93
1N277	43,530	10	0.02
1N429	110	0	0.00
1N457	3,011	0	0.00
1N458	14	0	0.00
1N459	32	2	6.25
1N538	6,480	4	0.06
1N629	632	5	0.79
1N645	2,011	0	0.00
1N691	1,597	0	0.00
1N746A	766	2	0.26
1N749A	506	0	0.00
1N751A	3,260	8	2.45
1N752A	342	1	0.29
1N754A	355	1	0.28
1N756A	358	2	0.56
1N758A	74	2	2.70
1N914	24	0	0.00
1N1202	42	0	0.00
1N1521A	96	0	0.00
1N1522A	68	0	0.00
1N1524A	36	0	0.00
1N1600	114	0	0.00
1N2032-2	2,349	0	0.00
1N3016B	12	0	0.00
1N3022-B	36	0	0.00
2N158	127	2	1.57
2N335	960	6	0.62
2N338	327	0	0.00
2N388	3,386	10	0.30
2N396A	2,819	6	0.21
2N492	133	0	0.00
2N525	1,411	4	0.28
2N553	130	0	0.00
2N595	992	2	0.20
2N599	1,236	3	0.24
2N604	5,329	23	0.43
2N682	61	7	11.48
2N697	1,087	5	0.46
2N699	637	1	0.16

Table 9. Semiconductor Electrical Defects Reported At Unit Test

Semiconductor Type	Number Used on Assemblies Tested At Unit Test	Number of Electrical Defects Reported	Percentage %
1N93	1,935	0	0.00
1N198B	163,750	69	0.04
1N231	8	0	0.00
1N250B	207	4	1.93
1N277	43,530	10	0.02
1N429	110	0	0.00
1N457	3,011	0	0.00
1N458	14	0	0.00
1N459	32	2	6.25
1N538	6,480	4	0.06
1N629	632	5	0.79
1N645	2,011	0	0.00
1N691	1,597	0	0.00
1N746A	766	2	0.26
1N749A	506	0	0.00
1N751A	3,260	8	2.45
1N752A	342	1	0.29
1N754A	355	1	0.28
1N756A	358	2	0.56
1N758A	74	2	2.70
1N914	24	0	0.00
1N1202	42	0	0.00
1N1521A	96	0	0.00
1N1522A	68	0	0.00
1N1524A	36	0	0.00
1N1600	114	0	0.00
1N2032-2	2,349	0	0.00
1N3016B	12	0	0.00
1N3022-B	36	0	0.00
2N158	127	2	1.57
2N335	960	6	0.62
2N338	327	0	0.00
2N388	3,386	10	0.30
2N396A	2,819	6	0.21
2N492	133	0	0.00
2N525	1,411	4	0.28
2N553	130	0	0.00
2N595	992	2	0.20
2N599	1,236	3	0.24
2N604	5,329	23	0.43
2N682	61	7	11.48
2N697	1,087	5	0.46
2N699	637	1	0.16

Table 9. Semiconductor Electrical Defects Reported At Unit Test (Cont)

Semiconductor Type	Number Used on Assemblies Tested At Unit Test	Number of Electrical Defects Reported	Percentage %
2N1026A	1,121	0	0.00
2N1039	285	1	0.35
2N1123	121	0	0.00
2N1132	26	0	0.00
2N1157	171	4	2.34
2N1253	91	0	0.00
2N1403	635	2	0.32
2N1450	19,212	63	0.33
2N1646	26,398	40	0.15
2N2004	916	0	0.00

Table 10. Electrical Defect Summary For Circuitron and Dynamic Unit Testing

Month	CIRCUITRON TESTING			UNIT TESTING		
	Number of Boards Tested	Average No. of Component Defects Per Board	Total No. of Defective Components	Number of Units Tested	Average No. of Component Defects Per Unit	Total No. of Defective Components
December 1962 through February 1963	5,262	0.47	2,474	7,420	0.13	966

Table 11. Component Electrical Defects at Unit Test

The columns are identified as follows:
A - Number of components used during the month
B - Number of defects reported
C - Percent reported defective
D - Percent of the total defects

	October-November 1962				December 1962-February 1963			
Component	A	B	C	D	A	B	C	D
Diodes	407,410	175	0.04	29.2	231,755	110	0.05	24.5
Transistors	120,847	227	0.19	37.9	67,611	178	0.26	39.6
Tubes	7,904	98	0.12	16.4	2,754	18	0.65	4.0
All Others	-	99	-	16.5	-	143	-	31.9
TOTAL	-	599	-	100.0	-	449	-	100.0

2. In-Factory AN/GPA-73 Reliability Data From Cabinet Environmental Tests

As mentioned in the previous report, AWCS-SQR-8, Part II, paragraph C.2, four cabinets were tested in accordance with the humidity tests described in MIL-E-5272A. Reliability Engineering worked with other engineering groups in evaluating the component failures from Cabinet 3. All electrical testing of the cabinets has been completed, following the humidity cycling.

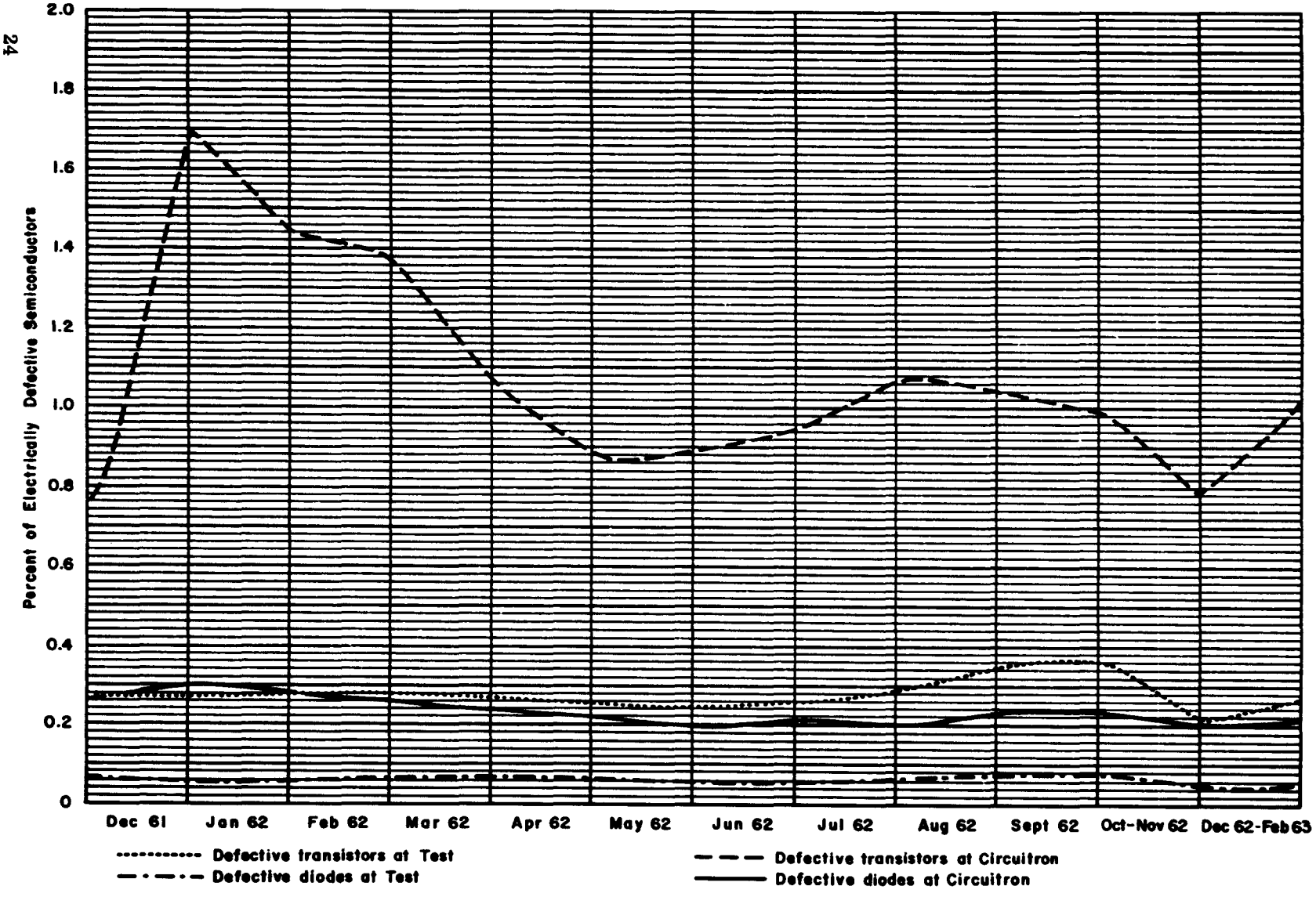

Figure 2. Monthly Semiconductor Electrical Defect Chart

There were 116,156 electrical piece parts in Cabinet 3, and there were 213 failures. This is less than 0.2 percent failures. The fact that there were failures was not surprising, considering the allowable failures due to humidity testing for a somewhat similar test, for electronic parts described in MIL-STD-202A which would allow a much higher rejection percentage. There were 1,068 printed wire board assemblies on which the major portion of the 116,156 electrical parts were mounted.

Failed parts analysis is not complete. There may be a problem with delay lines manufactured by one vendor. Failed lines have been returned to the vendors' plants for failure analysis. The results of their analysis has not been completed. Results will be included in a future report.

Although failure analysis of all other parts is not complete, the preliminary results do not indicate that there is a serious problem which would effect the field operation of any of the parts.

3. Failure Data and Reliability Measurement

a. Category I Test Reliability Data

The final report of the Category I Field Test Reliability Program was compiled during the quarter. Tables 12 through 31 present Availability, MTBF and MTTR Category I Test Site data extracted from the final report. The predicted values shown in these charts may not agree with predicted values appearing in Part I of this report. Any difference in these predicted values is due to the fact that Part I MTBF figures apply to general usage, and Part II MTBF figures are derived from the specific Watertown and Verona Test Site equipment configurations.

All MTBF and MTTR measurements presented in Part II are given in terms of hours. Data for these measurement computations were recorded in a Category I testing environment which had as a primary objective, the demonstration of the performance of the AN/GPA-73. Reference to the final report document (AWCS-SR-5) should be made when evaluating the Category I Test reliability measurement data in this report.

Table 12. AN/GPA-73 Data Processing and Display Subsystem Availability - Verona Category I Test Site

Nomenclature	Group Measured MTBF	Group Measured Failures/ 1000 Hr.	Group Measured MTTR	Group Repair Time (Hours)	Group No. of Failures
Detector-Tracker Group, Radar AN/FSA-12	18.06	55.38	0.83	211.26	254
Surveillance-Identification Group OA-1723	18.52	53.99	0.89	234.31	262
Height Data Group OA-1718	35.39	28.26	1.11	109.75	99
Site-To-Site Data Link Group OA-1724	24.20	41.33	0.54	94.21	173
Weapons Control Group AN/FSA-21	11.49	87.01	0.46	148.67	320
Jammer Tracking Group AN/FSA-23	38.08	26.26	1.50	130.52	87
Performance Monitor Group OA-3232	62.07	16.11	0.49	18.28	37
Situation Projection Group OA-3233	40.77	24.53	-	-	-
Status Display Group OA-3216	327.87	3.05	-	-	-
Totals		335.92		947.00	1,232

AN/GPA-73 Subsystem: Measured MTBF = 2.98 Hr.
Measured MTTR = 0.77 Hr.
Availability = 74.2%

Table 13. AN/GPA-73 Cabinet MTBF Measurements - Verona Category I Test Site

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)	Operational Hours	No. of Failures
Det.-Trkr. Gp. AN/FSA-12						
1 (1)	56.35	67.14	47.52	42.55	5,522	98
3 (1)	44.66	52.21	38.33	51.39	5,493	123
4 (1)	137.33	180.59	106.07	140.25	5,768	42
6 (2)	125.67	167.33	96.21	173.01	4,901	39
Surv.-ID. Gp. OA-1723						
24 (1)	141.64	190.97	107.21	595.24	5,099	36
26 (2)	88.28	109.92	71.67	93.11	5,650	64
26 (4)	135.21	180.72	103.17	93.11	5,138	38
27 (1)	182.64	256.98	133.04	240.96	5,114	28
27 (5)	258.79	394.94	176.24	240.96	4,917	19
28 (1)	483.73	865.20	292.36	234.74	5,321	11
28 (6)	246.56	380.62	166.22	234.74	4,438	18
32 (13)	78.53	96.16	64.70	59.88	5,811	74
Hgt. Data Gp. OA-1718						
44 (1)	161.14	218.27	121.47	94.88	5,640	35
46 (1)	335.13	673.62	185.54	311.53	2,681	8
46 (2)	174.89	269.98	117.90	311.53	3,148	18
47 (1)	141.79	216.39	96.56	359.71	2,694	19
47 (2)	158.70	239.55	109.26	359.71	3,174	20
Site-To-Site Data Link Gp. OA-1724						
35 (1)	112.68	149.34	86.54	105.71	4,507	40
36 (1)	164.15	277.14	103.34	157.23	2,134	13

Table 13. AN/GPA-73 Cabinet MTBF Measurements-Verona Category I Test Site (Continued)

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)	Operational Hours	No. of Failures
Site-To-Site Gp.						
Data Link Gp.						
OA-1724 (Cont)						
37 (1)	170.17	247.52	120.90	73.96	4,084	24
39 (7)	48.80	58.14	41.15	59.38	4,782	98
Weapons Control Gp.						
AN/FSA-21						
52 (3)	56.43	69.85	46.05	39.64	3,781	67
53 (4)	94.95	124.86	73.34	45.13	3,988	42
54 (5)	698.20	1,772.08	332.48	129.37	3,491	5
55 (1)	731.40	1,856.34	348.29	200.80	3,567	5
56 (3)	127.10	176.77	93.66	70.47	3,813	30
59 (1)	154.09	226.02	108.68	135.69	3,544	23
60 (3)	154.55	228.49	108.04	177.62	3,400	22
60 (4)	230.15	388.57	144.89	177.62	2,992	13
60 (5)	222.13	353.63	146.26	177.62	3,554	16
61 (3)	189.25	286.57	130.71	132.45	3,797	20
61 (4)	134.50	192.35	96.95	132.45	3,497	26
63 (2)	154.35	232.98	106.27	248.76	3,087	20
66 (3)	184.76	276.16	128.26	198.02	3,880	21
67 (2)	592.00	1,741.18	258.80	425.53	2,368	4
Jammer Trkng. Gp.						
AN/FSA-23						
109 (3)	51.84	63.48	42.71	54.56	3,836	74
110 (1)	804.00	2,941.46	311.23	318.47	2,412	3
110 (2)	1,535.00	8,647.89	487.30	318.47	3,070	2
111 (1)	197.00	352.36	119.07	119.05	2,167	11

Table 13. AN/GPA-73 Cabinet MTBF Measurements-Verona Category I Test Site (Continued)

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)	Operational Hours	No. of Failures
Perf. Mon. Gp. OA-3232						
72 (2)	2,265.00	44,411.76	477.85	645.16	2,265	1*
73 (2)	755.00	2,762.20	292.26	436.68	2,265	3
75 (3) (2)	-	-	-	1,333.33	- **	2
75 (4)	-	-	-	1,333.33	- **	2
76 (2)	156.29	258.93	99.91	207.04	2,188	14
77 (2)	125.83	194.25	84.83	162.60	2,265	18
*No failure recorded, 1 failure assumed. **Cabinet 75's (Portable Test Sets) operating hours not available.						
Situation Projection Gp. OA-3233						
82 (2)	224.00	514.94	113.42	50.45	1,344	6
83 (1)	1,344.00	26,352.94	283.54	33,333.33	1,344	1*
84 (2)	536.00	1,960.98	207.48	344.83	1,608	3
85 (1)	1,344.00	26,352.94	283.54	3,703.70	1,344	1*
87	-	-	-	-	-	-
88 (2)	99.29	144.42	70.54	207.47	2,383	24
89 (2)	150.38	302.26	83.25	111.23	1,203	8
90**	N.A.	-	-	N.A.	-	-
*No failure recorded, 1 failure assumed. **Cabinet 90, information not available to make a prediction.						

Table 13. AN/GPA-73 Cabinet MTBF Measurements-Verona Category I Test Site (Continued)

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)	Operational Hours	No. of Failures
Status Display Gp. OA-3216						
93 (7)	1,639.00	32,137.25	345.78	450.45	1,639	1
95	1,639.00	32,137.25	345.78	434.78	1,639	1*
97	N.A.**	-	-	50,000.00	-	-**
98 (2)	546.33	1,998.78	211.48	454.55	1,639	3

*No failure recorded, 1 failure assumed.
**Cabinet 97, limited use, no failure recorded.

Table 14. Group MTBF, Detector-Tracker Group, Radar AN/FSA-12 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
1	1	23.50	17.75
3	1	19.46	22.39
4	1	7.13	7.28
6	2	5.78	7.96
	Totals	55.87	55.38
	Group MTBF	17.90 Hr.	18.06 Hr.

Table 15. Group MTBF, Surveillance-Identification Group, OA-1723/GPA-73 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
24	1	1.68	7.06
26	2	10.74	11.33
26	4	10.74	7.40
27	1	4.15	5.48
27	5	4.15	3.86
28	1	4.26	2.07
28	6	4.26	4.06
32	13	16.70	12.73
	Totals	56.68	53.99
	Group MTBF	17.64 Hr.	18.52 Hr.

Table 16. Group MTBF, Height Data Group, OA-1718/GPA-73 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
44	1	10.54	6.21
46	1	3.21	2.98
46	2	3.21	5.72
47	1	2.78	7.05
47	2	2.78	6.30
	Totals	22.52	28.26
	Group MTBF	44.40 Hr.	35.39 Hr.

Table 17. Group MTBF, Site-To-Site Data Link Group OA-1724/GPA-73 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
35	1	9.46	8.87
36	1	6.36	6.09
37	1	13.52	5.88
39	7	16.84	20.49
	Totals	46.18	41.33
	Group MTBF	21.65 Hr.	24.20 Hr.

Table 18. Group MTBF, Weapons Control Group, AN/FSA-21 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
52	3	25.23	17.72
53	4	22.16	10.53

Table 18. Group MTBF, Weapons Control Group, AN/FSA-21 - Verona Category I Test Site (Continued)

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
54	5	7.73	1.43
55	1	4.98	1.37
56	3	14.19	7.87
59	1	7.37	6.49
60	3	5.63	6.47
60	4	5.63	4.34
60	5	5.63	4.50
61	4	7.55	7.43
61	3	7.55	5.28
63	2	4.02	6.48
66	3	5.05	5.41
67	2	2.35	1.69
	Totals	125.07	87.01
	Group MTBF	8.00 Hr.	11.49 Hr.

Table 19. Group MTBF, Jammer Tracking Group, AN/FSA-23 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
109	3	18.33	19.29
110	1	3.14	1.24
110	2	3.14	0.65
111	1	8.40	5.08
	Totals	33.01	26.26
	Group MTBF	30.29 Hr.	38.08 Hr.

Table 20. Group MTBF, Performance Monitor Group, OA-3232/GPA-73 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
72	2	1.55	0.44*
73	2	2.29	1.32
75	3(2)	0.75	-
75	4	0.75	-
76	2	4.83	6.40
77	2	6.15	7.95
	Totals	16.32	16.11**
	Group MTBF	61.27 Hr.	62.07 Hr.**

*No failure recorded, 1 failure assumed.
** Cabinet 75's (Portable Test Sets) Not included in the group calculation.

Table 21. Group MTBF, Situation Projection Group, OA-3233/GPA-73 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
82	2	19.82	4.46
83	1	0.03	0.74*
84	2	2.90	1.87
85	1	0.27	0.74*
87		-0-	-0-
88	2	4.82	10.07
89	2	8.99	6.65
90		N.A.**	N.A.
	Totals	36.83***	24.53***
	Group MTBF	27.15***	40.77***

N.A. = Not Available
*No failure recorded, 1 failure assumed.
** Information not available to make a prediction.
***Cabinet 90 excluded.

Table 22. Group MTBF, Status Display Group, OA-3216/GPA-73 - Verona Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
93	7	2.22	0.61*
95		2.30	0.61*
97		0.02	N.A.**
98	2	2.20	1.83
	Totals	6.74	3.05***
	Group MTBF	148.37 Hr.	327.87 Hr.***

N.A. = Not Available
*No failure recorded, 1 failure assumed.
**Limited use, no failure recorded.
***Cabinet 97 excluded.

Table 23. MTBF for the Power Supply Groups - Verona Category I Test Site

Unit	Serial Number	Accumulated Hours	Number of Failures	Measured MTBF (m_m)	Upper 90% MTBF Limit (m_{ul})	Lower 90% MTBF Limit (m_{ll})	Predicted MTBF (m_p)
130 Data Processing Power Supplies	1, 2, 13, 14, 30, and 31	33,118	9	3,679.78	7,061.41	2,109.43	4,347.83
131 Data Processing Power Supplies	28 and 29	7,983	1*	7,983.00	156,529.41	1,684.18	8,333.33
*No failure recorded, 1 failure assumed.							
140 Display Power Supplies	1(15), 2, 13, 14, 18, and 30	26,094	10	2,609.40	4,787.89	1,539.47	543.48

Table 24. AN/GPA-73 Data Processing and Display Subsystem Availability - Watertown Category I Test Site

Nomenclature	Group Measured MTBF	Measured Failures/ 1000 Hr.	Group Measured MTTR	Group Repair Time (Hours)	Group No. of Failures
Detector-Tracker Group, Radar AN/FSA-12	19.32	51.77	0.81	67.90	84
Surveillance-Identification Group OA-1723	19.85	50.39	0.76	63.30	83
Site-To-Site Data Link Group OA-1724	24.78	40.36	1.05	121.52	116
Totals		142.52		252.72	283

AN/GPA-73 Subsystem: Measured MTBF = 7.02 Hr.
Measured MTTR = 0.89 Hr.
Availability = 87.3%

Table 25. GPA-73 Cabinet MTBF Measurements - Watertown Category I Test Site

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)	Operational Hours	No. of Failures
Det.-Trkr. Gp. AN/FSA-12						
1 (3)	47.56	59.00	38.75	42.55	3,139	66
3 (3)	43.86	53.82	36.09	51.39	3,202	73
4 (3)	166.53	254.14	113.41	140.25	3,164	19
7 (8)	515.50	1,185.06	261.01	347.22	3,093	6
Surv.-ID Gp.						
24 (3)	114.88	165.72	82.20	595.24	2,872	25
26 (3)	73.64	98.05	56.38	93.11	2,872	39
27 (4)	120.86	178.69	84.49	240.96	2,659	22
28 (5)	253.73	453.82	153.35	234.74	2,791	11
30 (6)	62.88	80.97	49.56	94.88	3,081	49
Site-To-Site Data Link Gp. OA-1724						
34 (1)	33.83	40.74	28.22	74.68	2,943	87
37 (2)	92.55	128.14	68.51	73.96	2,869	31

Table 26. Group MTBF, Detector-Tracker Group, Radar AN/FSA-12 - Watertown Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
1	3	23.50	21.03
3	3	19.46	22.80
4	3	7.13	6.00
7	8	2.88	1.94
	Totals	52.97	51.77
	Group MTBF	18.88 Hr.	19.32 Hr.

Table 27. Group MTBF, Surveillance-Identification Group, OA-1723/GPA-73 - Watertown Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
24	3	1.68	8.70
26	3	10.74	13.58
27	4	4.15	8.27
28	5	4.26	3.94
30	6	10.54	15.90
	Totals	31.37	50.39
	Group MTBF	31.88 Hr.	19.85 Hr.

Table 28. Group MTBF, Site-To-Site Data Link Group, OA-1724/GPA-73 - Watertown Category I Test Site

Cabinet No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
34	1	13.39	29.56
37	2	13.52	10.80
	Totals	26.91	40.36
	Group MTBF	37.16 Hr.	24.78 Hr.

Table 29. MTBF for the Power Supply Groups - Watertown Category I Test Site

Unit	Serial Number	Accumulated Hours	Number of Failures	Measured MTBF (m_m)	Upper 90% MTBF Limit (m_{ul})	Lower 90% MTBF Limit (m_{ll})	Predicted MTBF (m_p)
130 Data Processing Power Supplies	15,16,17	12,085	4	3,021.25	8,886.03	1,320.77	4,347.83
140 Display Power Supplies	12	4,097	5	819.40	2,079.70	390.19	543.48

Table 30. AN/GPA-73 MTTR Data - Verona Category I Test Site

Cabinet (Serial No.)	No. of Failures	Measured MTTR (Hours)
1 (1)	90	0.95
3 (1)	96	0.79
4 (1)	35	0.81
6 (2)	33	0.66
Detector-Tracker Group AN/FSA-12		0.83
24 (1)	34	1.02
26 (2)	58	0.94
26 (4)	35	0.96
27 (1)	25	0.86
27 (5)	19	0.87
28 (1)	11	0.60
28 (6)	18	0.74
32 (13)	62	0.86
Surveillance-Identification Group OA-1723		0.89
44 (1)	36	1.15
46 (2)	16	1.50
46 (1)	9	1.32
47 (1)	19	0.92
47 (2)	19	0.79
Height Data Group OA-1718/GPA-73		1.11
35 (1)	39	0.60
36 (1)	14	0.26
37 (1)	24	0.33
39 (7)	96	0.62
Site-to-Site Data Link Group OA-1724		0.54
52 (3)	66	0.20
53 (4)	42	0.57
54 (5)	6	0.92
55 (1)	6	0.79
56 (3)	31	0.32
59 (1)	21	0.73
60 (3)	23	0.49
60 (4)	14	0.44
60 (5)	17	0.61

Table 30. AN/GPA-73 MTTR Data - Verona Category I Test Site (Continued)

Cabinet (Serial No.)	No. of Failures	Measured MTTR (Hours)
61 (4)	26	0.35
61 (3)	21	0.26
63 (2)	21	0.41
66 (3)	22	1.04
67 (2)	4	0.58
Weapons Control Group AN/FSA-21		0.46
109 (3)	68	1.50
110 (1)	4	1.40
110 (2)	3	2.94
111 (1)	12	1.16
Jammer Tracking Group AN/FSA-23		1.85
72 (2)	-	-
73 (2)	3	0.57
75 (3) (2)	-	-
75 (4)	-	-
76 (2)	15	0.27
77 (2)	19	0.66
Performance Monitor Group OA-3232		0.49*
82 (2)	5	1.44
83 (1)	0	N.A.
84 (2)	4	1.71
85	0	N.A.
87	0	N.A.
88 (2)	24	1.68
89 (2)	9	0.28
90	0	N.A.
Situation Projection Group OA-3233		N.A.

*Cabinets 73(2), 76(2), and 77(2) data only included in the Performance Monitor Group.

N.A. = Not Available

Table 30. AN/GPA-73 MTTR Data - Verona Category I Test Site (Continued)

Cabinet (Serial No.)	No. of Failures	Measured MTTR (Hours)
93 (7)	1	2.93
95	0	N.A.
97	0	N.A.
98 (2)	2	2.08
99	0	N.A.
Status Display Group OA-3216		N.A.

N.A. = Not Available

Table 31. AN/GPA-73 MTTR Data - Watertown Category I Test Site

Cabinet (Serial No.)	No. of Failures	Measured MTTR (Hours)
1 (3)	21	0.52
3 (3)	45	0.94
4 (3)	12	0.83
7 (8)	6	0.81
Detector-Tracker Group AN/FSA-12		0.81
24 (3)	8	0.60
26 (3)	31	0.65
27 (4)	7	0.73
28 (5)	1	1.09
30 (6)	36	0.90
Surveillance-Identification Group OA-1723		0.76
34 (1)	86	1.02
37 (2)	30	1.12
Site-to-Site Data Link Group OA-1724		1.05

b. Category II Test Reliability Data

No Category II Test reliability data analysis is available for this report. The reliability data reporting program is in progress at the test sites. The Category II Reliability Measurement Program is discussed in Part I, paragraph E.1 of this report.

c. USAFE Reliability Data

Tables 32 through 45 present an MTBF analysis of measurement data of the Detector-Tracker, Surveillance-Identification, and Site-To-Site Data Link Equipment Groups at Sites F and I. The measurement values are presented as preliminary figures, based on failure data reported throughout the equipment installation and installation checkout cycles.

Table 32. AN/GPA-73 Cabinet MTBF Measurements, USAFE - Site F, Detector-Tracker Group, Radar AN/FSA-12

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)
3 (4)	69.19	89.64	54.26	51.39
5 (13)	N.A.	N.A.	N.A.	1,086.57
7 (4)	342.38	688.19	189.55	347.22

N.A. = Not Available - Insufficient Data

Table 33. AN/GPA-73 Cabinet MTBF Measurements, USAFE - Site F, Surveillance-Identification Group, OA-1723/GPA-73

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)
23 (5)	45.50	54.74	38.07	70.32
26 (9)	46.31	57.54	37.66	93.11
28 (8)	278.63	560.05	154.26	234.74
28 (9)	266.67	463.77	164.52	234.74

Table 33. AN/GPA-73 Cabinet MTBF Measurements, USAFE - Site F, Surveillance-Identification Group, OA-1723/GPA-73 (Continued)

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)
28 (10)	231.92	403.33	143.08	234.74
29 (8)	85.29	115.52	64.29	183.15

Table 34. AN/GPA-73 Cabinet MTBF Measurements, USAFE - Site F, Site-To-Site Data Link Group, OA-1724/GPA-73

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)
34 (2)	70.71	90.58	55.98	74.68
37 (4)	156.79	228.06	111.40	73.96

Table 35. Group MTBF, Detector-Tracker Group, Radar AN/FSA-12, USAFE - Site F

Unit No.	Serial No.	Failure Rate (Failures/1000 Hrs.) Predicted	Measured
3	4	19.46	14.45
5	13	0.92	N.A.
7	4	2.88	2.92
	Totals	23.26	-
	Group MTBF	42.99 Hr.	-

N.A. = Not Available - Insufficient Data

Table 36. Group MTBF, Surveillance-Identification Group, OA-1723/GPA-73, USAFE - Site F

Unit No.	Serial No.	Failure Rate (Failure/1000 Hrs.) Predicted	Measured
23	5	14.22	21.98
26	9	10.74	21.59
28-1	8	4.26	3.59
28-2	9	4.26	3.75
28-3	10	4.26	4.31
29	8	5.46	11.72
	Totals	43.20	66.94
	Group MTBF	23.15 Hr.	14.94 Hr.

Table 37. Group MTBF, Site-To-Site Data Link Group, OA-1724/GPA-73, USAFE - Site F

Unit No.	Serial No.	Failure Rate (Failures/1000 Hrs.) Predicted	Measured
34	2	13.39	14.14
37	4	13.52	6.38
	Totals	26.91	20.52
	Group MTBF	37.16	48.73

Table 38. AN/GPA-73 Cabinet MTBF Measurements, USAFE - Site I, Detector-Tracker Group, Radar AN/FSA-12

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)
2 (5)	52.27	67.52	41.08	50.86
3 (6)	41.91	51.82	34.25	51.39
4 (6)	237.50	413.04	146.53	140.25
7 (6)	N.A.	N.A.	N.A.	347.22

Table 39. AN/GPA-73 Cabinet MTBF Measurements, USAFE - Site I, Surveillance-Identification Group, OA-1723/GPA-73

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)
24 (5)	76.68	106.16	56.76	595.24
26 (11)	66.28	86.94	51.39	93.11
26 (12)	57.36	71.17	46.74	93.11
27 (9)	170.60	257.51	117.45	240.96
27 (10)	260.36	465.69	157.36	240.96
28 (16)	692.75	2,037.50	302.84	234.74
28 (18)	318.63	640.45	176.40	234.74
29 (30)	N.A.	N.A.	N.A.	183.15
30 (8)	62.04	76.70	50.90	94.88

N.A. = Not Available - Insufficient Data

Table 40. AN/GPA-73 Cabinet MTBF Measurements, USAFE - Site I, Site-To-Site Data Link Group, OA-1724/GPA-73

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)
34 (3)	30.68	36.06	26.29	74.68
35 (7)	N.A.	N.A.	N.A.	105.71
36 (7)	N.A.	N.A.	N.A.	157.23
38 (17)	191.10	350.64	112.74	180.83

Table 41. AN/GPA-73 Cabinet MTBF Measurements, USAFE - Site I, Height Data Group, OA-1718/GPA-73

Cabinet (Serial No.)	Measured MTBF (Hours)	Upper 90% MTBF Limit	Lower 90% MTBF Limit	Predicted MTBF (Hours)
44 (5)	60.84	81.32	46.43	94.88
45 (5)	55.09	69.90	44.01	184.84
46 (8)	82.50	116.08	60.09	311.53
46 (7)	76.63	106.58	56.47	311.53

Table 42. Group MTBF, Detector-Tracker Group, Radar AN/FSA-12, USAFE - Site I

Unit No.	Serial No.	Failure Rate (Failures/1000 Hrs.) Predicted	Measured
2	5	19.66	19.13
3	6	19.46	23.86
4	6	7.13	4.21
7	6	2.88	N.A.
	Totals	49.13	-
	Group MTBF	20.35 Hr.	-

N.A. = Not Available - Insufficient Data

Table 43. Group MTBF, Surveillance-Identification Group, OA-1723/GPA-73, USAFE - Site I

Unit No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
24	5	1.68	13.04
26-1	11	10.74	15.09
26-2	12	10.74	17.43
27-1	9	4.15	5.86
27-2	10	4.15	3.84
28-1	16	4.26	1.44
28-2	18	4.26	3.14
29	30	5.46	N.A.
30	8	10.54	16.12
	Totals	60.13	-
	Group MTBF	16.63 Hr.	- Hr.

N.A. = Not Available - Insufficient Data

Table 44. Group MTBF, Site-To-Site Data Link Group, OA-1724/GPA-73, USAFE - Site I

Unit No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
34	3	13.39	32.59
35	7	9.46	N.A.
36	7	6.36	N.A.
38	17	5.53	5.23
	Totals	34.74	-
	Group MTBF	28.79 Hr.	-

N.A. = Not Available - Insufficient Data

Table 45. Group MTBF, Height Data Group, OA-1718/GPA-73, USAFE - Site I

Unit No.	Serial No.	Failure Rate (Failures/1000 Hrs.)	
		Predicted	Measured
44	5	10.54	16.44
45	5	5.41	18.15
46-1	8	3.21	12.12
46-2	7	3.21	13.05
	Totals	22.37	59.76
	Group MTBF	44.70 Hr.	16.73 Hr.

4. Failure Investigations (See Table 46)

a. Synchro No. 7727736P5

Failures of this synchro were mentioned in the previous report (AWCS-SQR-8) in Part II, paragraph C.4.b. Further evaluation of new units by Engineering Standards and Engineering Design indicated the need to change the purchase part specifications so that replacement units will be able to operate over a wider range of input voltages than was originally specified. The purchased part drawing is being changed to include the new requirements. It was found that only one vendor's product being used failed to pass the new requirements. It was also determined by personnel in the European environment that at least one failure was caused by a cabling defect, external to the synchro unit.

b. ZA-1 and OPA-1 Printed Wire Boards

The investigation of failures of these printed wire boards was included in the last report (AWCS-SQR-8) in Part II, paragraph C.4.e. Changes are being made in the ZA-1 and ZA-2 boards to correct problems of adjustment and instability caused by excessive grid leakage in 6,021 tubes used on the OPA-1 and OPA-2 boards. ECR-1031 and 1032 have been issued to change resistors on the ZA-1 and ZA-2 boards so that they will correct over a wider range of error voltage when used with the OPA-1 and OPA-2 boards. Correction of this problem should increase the measured Mean Time Between Failures on cabinets in the GPA-73 where these boards are used.

c. IN231 Diodes

It was found that 30 to 50 percent of the SWG-1 printed wire boards were being rejected because the IN231 diode was out of tolerance. The board test specification required the diode to have a zener operating characteristic of 29 volts plus or minus 2 volts. The specification for the diode allowed a 29 volt plus 3 volts or minus 4 volts zener breakdown voltage. A review of the board design by the circuit designer allowed the board test specification to be changed to agree with the diode specification limits. IP30392 was issued to change the test specification.

d. CS-1 and CS-2 Printed Wire Boards

Work has been started to investigate the failures of CS-1 and CS-2 printed wire boards in the European environment. This work is being done in conjunction with Circuit Design Engineering. Results will be included in future reports.

e. Type 6336 Tubes

Reports of failures of 6336 tubes in Power Supply Cabinet 140 in the Category II environment are being investigated. Failed tubes have been requested, but have not been received. After the tubes are received an analysis will be made.

f. Delay Line 7759986

Reports from the European environment concerning the malfunction of the heater circuits in the delay lines will be investigated when the line which is being returned is received.

g. Motor 7748560P1

An analysis of the failure of the motor from the European environment will be made as soon as the failed part is received from the environment.

h. Motor 7496045

This failure investigation was mentioned in the previous report (AWCS-SQR-8) in Part II, paragraph C.4.f. It was determined that heat caused a deterioration of the grease in the motor bearings and gear reduction assembly. The grease deterioration would not allow the motor to turn freely, resulting in low speeds. ECR924 was issued to install a heat sink on the motor. This should be a solution to the problem of over-heating.

i. VEG-2 Printed Wire Board

Reports from the European environment indicated that there had been trouble with the board. Working with Display Design Engineering, the board was evaluated, and voltage measurements did not reveal any deficiencies. One of the failed boards has been requested to be returned for evaluation. The evaluation will continue after the board has been returned.

j. IN458 Diode

In-factory reporting during the previous quarter indicated that the rejection rate for this diode from dynamic unit test was higher than expected. No definite causes for the high rate could be established, since the sample size of 18 pieces used was small. Reports for this quarter from dynamic unit test does not show any rejections for a sample of 14 units used. The investigation will be considered complete unless further data indicates that there is a problem.

Table 46. Failure Investigation Corrective Action Table

Item	Description of Problem	Corrective Action	Investigation Status
2	7727736P5 Synchro Failures. Reference Part II, paragraph C.4.a.	Purchase part drawing electrical specification changed to include maximum input power requirement at increased voltage.	Completed.
5	ZA-1 and OPA-1 Printed Wire Board failures. Reference Part II, paragraph C.4.b.	ECR1030 and ECR1031 to change resistors on ZA-1 and ZA-2 boards.	Completed.
6	7496045 Motor failure due to grease breakdown in gear reduction unit. Reference Part II, paragraph C.4.h.	ECR924 issued to install a heat sink on motor for increased heat dissipation.	Completed.
7	IN231 Diode rejections at test. Reference Part II, paragraph C.4.c.	IP30392 issued to change Unit Test Specification for SWG-1 printed wire board.	Completed.
8	IN458 Diode rejections at test. Reference Part II, paragraph C.4.j.	None required.	Completed.
9	CS-1 and CS-2 Printed Wire Board failures in European Environment. Reference Part II, paragraph C.4.d.	None required.	Incomplete.
10	Type 6336 Tubes. Reference Part II, paragraph C.4.e.	None required.	Incomplete. Awaiting return of failed parts.
11	Delay Line 7759986. Reference Part II, paragraph C.4.f.	None required.	Incomplete. Awaiting return of failed parts.
12	Motor 7748560P1. Reference Part II, paragraph C.4.g.	None required.	Incomplete. Awaiting return of failed parts.
13	VEG-2 Printed Wire Board. Reference Part II, paragraph C.4.i.	None required.	Partially completed. Awaiting return of failed parts.

5. Laboratory Printed Wire Board Life Test

A special printed wiring board life test was constructed and put into operation during the year 1961. The previous quarterly report (AWCS-SQR-8) mentioned the life test in Part II, paragraph 6. Table 47 lists the board types and the quantity being used in the tests. Table 48 lists the components, their drawing numbers, and the quantity being energized in the life test. Table 49 is a listing of the results of the tests after 13,306 hours of operation.

The components were grouped into the "Component Groupings" as listed in Table 49. The "Component Hours" column is the product of the number of components in that grouping and the hours of operation. Since there have been no failures, the "Number of Failures" column and "Actual Failure Rate" column have all zero entries. The "Predicted Failure Rate" column contains the failure rates used for the prediction of reliability of the AN/GPA-73 equipment.

Since there have been no failures, the actual failure rates are zero. To make the data more meaningful, the failure rates were calculated by assuming a failure at 13,306 hours. These calculations of the failure rates are shown in the column labeled "Failure Rate Assuming One Failure".

The column "Upper 90% Confidence Limit" gives the statistical calculation of the failure rates, with a probability of 95 percent that the actual failure rate is less than the value indicated. Although the values do not approach the predicted failure rates at this time, it is expected that the two values will approach each other as more operating hours are logged on the test.

The boards are mounted in a manner similar to that which would be used in the AN/GPA-73 equipment. One chassis of boards has the same logic diagrams as a clock-chassis used in the AN/GPA-73. The additional boards are used as a self-checking circuit, which gives a visual indication of failure on any board. The environmental conditions of operation are that of a normal air-conditioned laboratory which has an ambient temperature of 25°C. There are no efforts to house the boards or have forced air-circulation. The only air-circulation is from convection currents.

Table 47. Board Types Used in Board Life Test

Board Type	Quantity Used
BP-2	1
BP-3	2
CA-1	4
CA-2	1
CG-1	1
CL-1	2
DR-3	1
DR-4	1
FF-2	2
HL-3	1
HL-5	3
LT-4	1
ND-1	1
RD-1	1
SC-1	3
WC-1	4
WC-2	1
WM-1	1
WP-1	1

Table 48. Component Types Used in Board Life Test

Component Type	Component Drawing No.	Number Used
Diode	1N198B	371
Diode	1N2032-2	5
Diode	1N277	177
Diode	1N457	26
Diode	1N538	9
Diode	1N691	10
Diode	1N645	1
Diode	1N746A	1
Diode	1N751A	21

Table 48. Component Types Used in Board Life Test (Continued)

Component Type	Component Drawing No.	Number Used
Diode	1N752A	4
Transistor	2N1301	6
Transistor	2N1039	6
Transistor	2N1403	1
Transistor	2N1450	46
Transistor	2N1646	67
Transistor	2N388	1
Transistor	2N396A	2
Transistor	2N599	24
Transistor	2N604	53
Transistor	2N697	25
Resistor	RC20GF	612
Resistor	RC32GF	40
Resistor	RC42GF	25
Resistor	RN65B	39
Resistor	3R153P	8
Resistor	7717791	8
Capacitor	CL25	24
Capacitor	CC36C	8
Capacitor	CM20C	10
Capacitor	7713040	115
Capacitor	7203760	2
Capacitor	7741850	153
Capacitor	7742510	4
Relay	7747913	1
Crystal	7747388	1
Delay Line	7747946P1	7
Coil	7722350P14	5
Coil	7724181P19	2
Coil	7747952	16
Coil	7748576	8

Table 48. Component Types Used in Board Life Test (Continued)

Component Type	Component Drawing No.	Number Used
Transformer	7742843	17
Transformer	7745709	6
Transformer	7748567	18
Switch	7745171	3

Table 49. Failure Rates As Based On Data From Board Life Test (13,306 Hours)

Component Grouping	Number of Components	Component Hours	Number of Failures	Actual Failure Rate	Predicted Failure Rate %/1000 Hrs.	Failure Rate Assuming One Failure %/1000 Hrs.	Upper 90% Confidence Limit * %/1000 Hrs.
Diodes							
Germanium (Signal)	371	4,936,526	0	0	0.02	0.02	0.06
Silicon (Signal)	223	2,967,238	0	0	0.02	0.03	0.10
Silicon (Zener)	31	412,486	0	0	0.02	0.24	0.72
Transistors							
Germanium (Power)	6	79,836	0	0	0.20	1.25	3.75
Germanium (Signal)							
Mesa	68	904,808	0	0	0.05	0.11	0.33
Drift	99	1,317,294	0	0	0.10	0.08	0.23
Others	27	359,262	0	0	0.07	0.28	0.83
Silicon	25	352,550	0	0	0.05	0.30	0.90
Resistors							
Fixed (Composition)	677	9,008,162	0	0	0.03	0.01	0.03
Fixed (Wirewound Precision)	8	106,448	0	0	0.10	0.94	2.81
Fixed (Carbon Film)	39	518,934	0	0	0.04	0.19	0.58
Variable (Wirewound)	8	106,448	0	0	0.15	0.94	2.81
Capacitors							
Ceramic	8	106,448	0	0	0.04	0.94	2.81
Mica	125	1,663,250	0	0	0.04	0.06	0.18
Mylar	159	2,115,654	0	0	0.06	0.05	0.14
Tantalum	24	319,344	0	0	0.20	0.31	0.94
Transformers (Pulse)	41	545,546	0	0	0.05	0.18	0.55

Table 49. Failure Rates as Based on Data From Board Lift Test (13,306 Hours) - (Continued)

Component Grouping	Number of Components	Component Hours	Number of Failures	Actual Failure Rate	Predicted Failure Rate %/1000 Hrs.	Failure Rate Assuming One Failure %/1000 Hrs.	Upper 90% Confidence Limit %/1000 Hrs.
Delay Line (Lumped Constant)	7	93,142	0	0	0.30	1.07	3.21
Coils (R. F.)	31	412,486	0	0	0.09	0.24	0.72
Switches	3	39,918	0	0	0.20	2.51	7.49
Crystals (Quartz)	1	13,306	0	0	0.02	7.52	22.47
Relays (Miniture)	1	13,306	0	0	0.30	7.52	22.47

*Probability is 0.95 that the true failure rate is less than the value shown in this column.

D. PRODUCTION RELIABILITY

1. Reliability Indoctrination of Factory Personnel

There was no formal reliability indoctrination during this quarter, but informal indoctrination was conducted.

2. Failure Rate Studies Associated With The Manufacturing Process

The contact resistance study, referenced in the previous two studies, has been updated with additional aging information. The conclusion is that there is no significant difference between 25 micro inches of gold and 100 micro inches with 25 board insertions and withdrawals over a six-month period. A sample of 100 boards from the Verona and Building 15 Test Sites indicates there is no gold thickness problem below 25 micro inches. Therefore, it has been concluded that a massive field gold plated board contact finger measuring and plating program is not warranted.

Production Reliability also gave direction and approval for a board refurbishing program for the cabinets that had undergone a 10-day humidity test.

3. Parts Application Standards As Applied To The Manufacturing Process

The decision was made to remove some transistors with gold plated leads that had gone through the 10-day humidity test mentioned in the above paragraph.

4. Design Audit Of The Product End

There were no product design audits during this quarter.

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